CHAPTER 5

SYSTEM FILTERS

FLUID FILTERS

Purpose. Filters can remove practically all foreign particles found in hydraulic fluid. The degree of filtration needed depends on the acceptance level desired. Most high-pressure hydraulic systems use filters that have a 10- to 15-micron capability, but many later-model aircraft have 5-micron filters. Two-stage filters, one element of which has a 3-micron capability, are found in some recent models. When you consider that 1 micron equals one-millionth of a meter, you can appreciate the tremendous capability of these filters. They are, however, intended primarily to safeguard the operation of certain important units by filtering out foreign particles generated by the wear and tear of parts in the system. They cannot handle large quantities of foreign matter from outside the system.

Location. Fluid filters may be located in the pressure line, in the return line, or in any other location where they are needed to safeguard the system against foreign particles in the fluid. However, filters are not normally used in system supply lines. There are many models of filters, the variation being necessitated by the location of the filter within the particular aircraft.

Construction. The filtering elements in fluid filters are normally made of paper or stainless steel. Paper elements are used mostly in low-pressure systems and are thrown away when removed. Stainless steel elements are used in both high-pressure and low-pressure systems and may be reused. The size and shape of each element depend on its use and installation; however, all fluid filter assemblies are made up of three basic units: filter head, filter bowl, and filter element.

Figure 5-1 illustrates a typical fluid filter assembly where the differential pressure indicator is located in the top of the filter head assembly. (In some designs, the indicator is located on the side of the filter head assembly.) Also located within the head is a bypass valve assembly which routes hydraulic fluid directly from the inlet to the outlet

port if the filter element becomes clogged with foreign matter. The filter bowl is the housing that holds the element to the head assembly and is the part that is removed when the filter element is replaced.

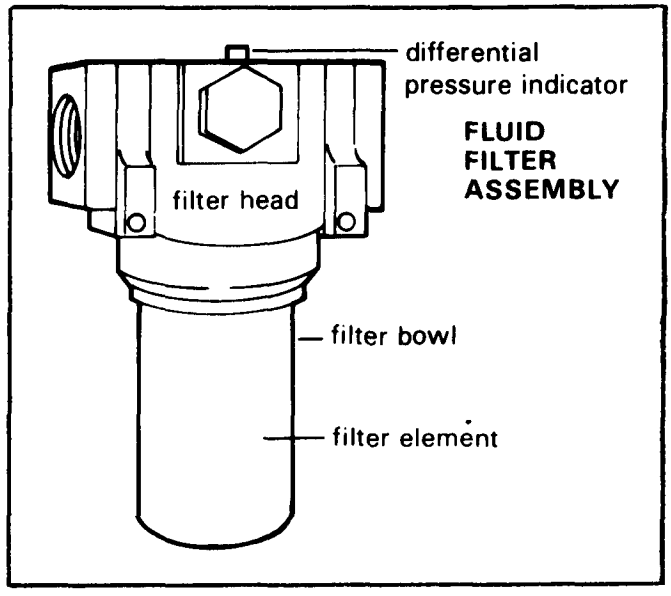

Figure 5-1. Fluid filter assembly.

Types. The three types of fluid filters used in hydraulic systems are filters with paper elements, filters with stainless steel elements, and two-stage filters.

Fluid Filters With Paper Elements. A typical fluid filter with a paper element removes 99 percent of all particles that are 10 microns (0.000394 inch) in diameter and larger. For example, if 100 particles measuring 0.000394 inch in cross section were dropped into pure hydraulic fluid, a 10-micron filter would intercept 99 percent of these particles in one pass. A 40-micron particle is considered the smallest that can be seen without magnification.

The filter has an external thread machined on the outside and top of the filter bowl which fits in the underside of the body assembly. A groove machined around the base of the threads provides for the packing between the filter bowl and the body assembly.

Hydraulic fluid enters the filter through the inlet port in the body assembly and flows around the element inside the filter bowl. element, like those used in the reservoir, is made of specially treated cellulose paper formed in accordion-like pleats to present the maximum filtering surface to the fluid. Filtering takes place as the fluid passes through the filtering element at the hollow core, leaving the dirt and impurities on the outside of the filter element. Filtered fluid then flows from the hollow core to the outlet port in the body and into the system. Figure 5-2 illustrates a fluid filter with a normal flow of fluid.

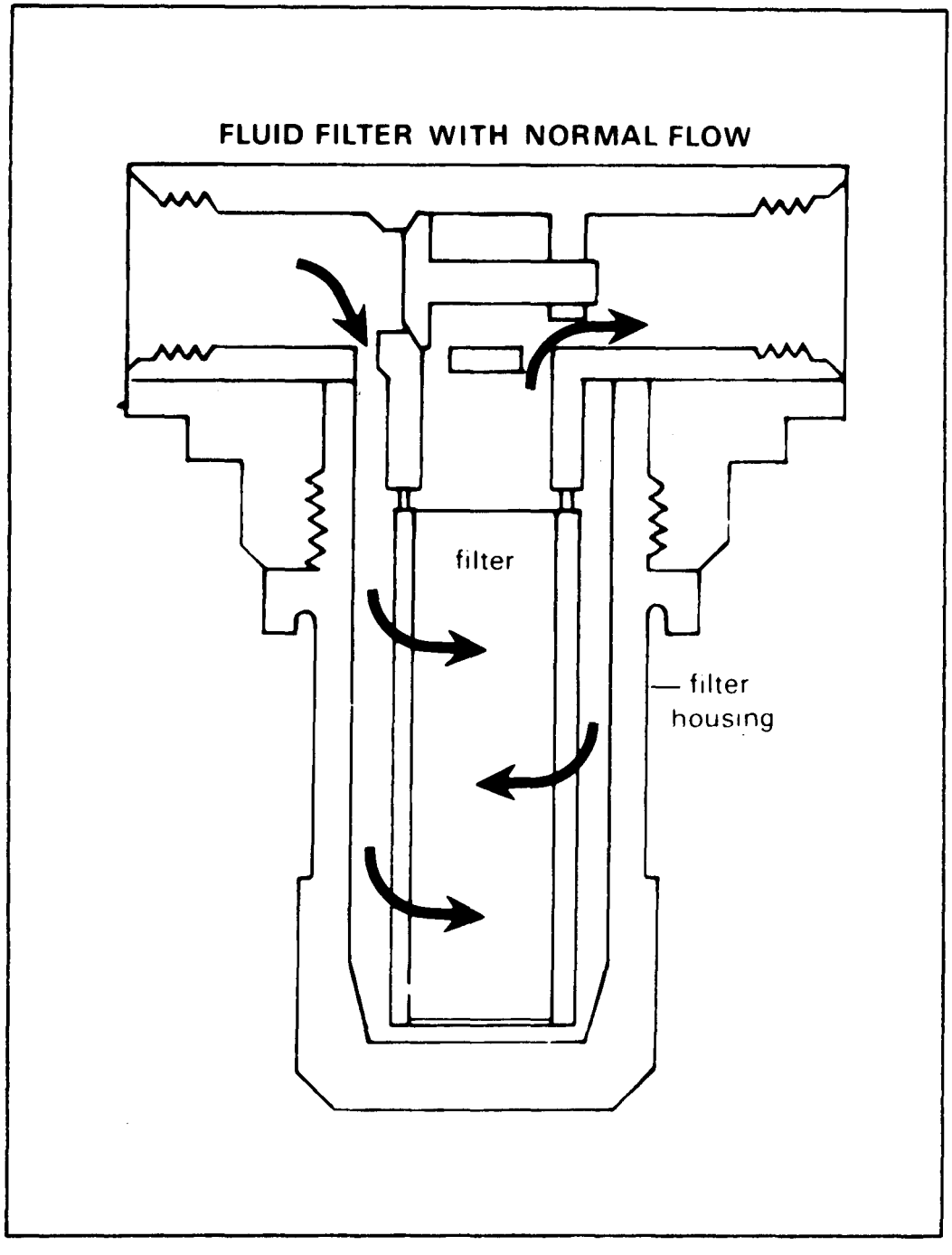

Figure 5-2. Fluid filter with normal flow.

The bypass pressure-relief valve in the body allows the fluid to bypass the filter element and pass directly through the outlet port in case the filter element becomes clogged. In most filters of this type, the relief

valve is set to open if the pressure drop exceeds 50 psi; for example, if the pressure at the filter inlet port was 70 psi, and the pressure at the outlet port dropped below 20 psi, the relief valve would open. (See Figure 5-3.)

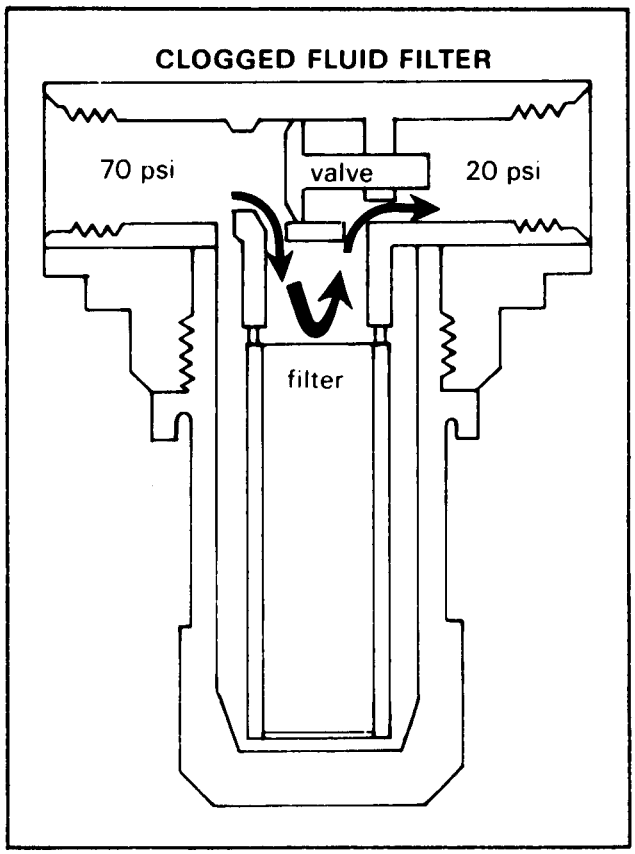

Figure 5-3. Clogged fluid filter.

Paper filter elements are replaced on a scheduled basis, depending on the needs of the specific aircraft system. Replacing unscheduled filter elements is also required when certain components are removed. Never try to gage the condition of a filter by visual inspection alone. Since the naked eye cannot detect particles smaller than 40 microns, an element could be heavily contaminated with 10- to 20-micron particles. The only way this condition could be determined would be by performing a back-pressure flow check on a test stand. Another danger of relying on visual inspection alone is that while filter elements may seem identical in outward appearance and in physical dimensions, they differ internally. For this reason, filters must always be identified by part numbers. Filters installed in the wrong fluid will go to pieces and cause major problems in the hydraulic system. To remove and replace paper filter elements--

- Relieve system pressure by operating the main system bypass valve or by actuating a hydraulically operated unit.
- Depressurize reservoir (if necessary).

- Cut lockwire.
- Unscrew the filter case and remove it from the filter head using a slight rocking and downward pull on the case after the case threads are free from the filter.
- Extract the retaining ring and remove the filter element from the case.
- Cut the filter element after ensuring that a replacement filter element is available, and inspect it internally for evidence of system contamination.
- Before installing the new filter, clean the filter head and case, and inspect them for damage; replace all damaged parts.
- Replace all O-ring packings.
- Fill the filter bowl with new fluid before attaching it to the filter housing head. Filling the bowl helps to stop the injection of air into the system.
- Install the filter in its case, and screw the case into the filter head. The correct torque is usually hand-tight plus one-eighth of a turn, but always check the appropriate maintenance manual for the specific torque value.
- Pressurize the hydraulic system, and inspect the filter assembly for leaks. If the assembly is satisfactory, replace the lockwire between the filter case and head assembly.

Fluid Filters With Stainless Steel Elements. Stainless steel filter elements are used in most modern aircraft. Filter element surfaces of this type usually have a corrugated stainless steel mesh construction. Such filters are usually rated from 5- to 10-micron nominal flow and 25-micron absolute flow. This means about 95 percent of 5- to 10-micron particles and 100 percent of 25-micron particles will be filtered from the fluid. The curved passages of the filter element limit the length of the particles that pass through the filter.

Filters with a differential pressure indicator (Figure 5-4) operate on the difference between the pressure entering the element and the pressure after it leaves the element. When contaminating particles collect on the outside of the filter element, the differential pressure across the element increases. When this increased pressure reaches a specific value, inlet pressure forces the spring-loaded magnetic piston downward, breaking the magnetic attachment between the indicator button and the magnetic piston. This allows the red indicator on the differential pressure indicator to pop out, which indicates that the element must be cleaned. (See Figure 5-5.) Because increased fluid viscosity at low temperatures might cause a false indication of contamination, a low-temperature lockout of the differential pressure indicator prevents actuation at low temperatures. If the filter

element is not replaced when the indicator shows contamination, the filter element will continue to collect foreign particles, and the pressure differential between the inlet and outlet ports will increase until the bypass valve opens and directs fluid through the filter element bypass. A nonbypassing-type filter prevents contaminated fluid from passing through the filter element and contaminating the entire system. This type of filter reduces the need for flushing the entire system and lessens the chance of pumps and other components failing in the power system.

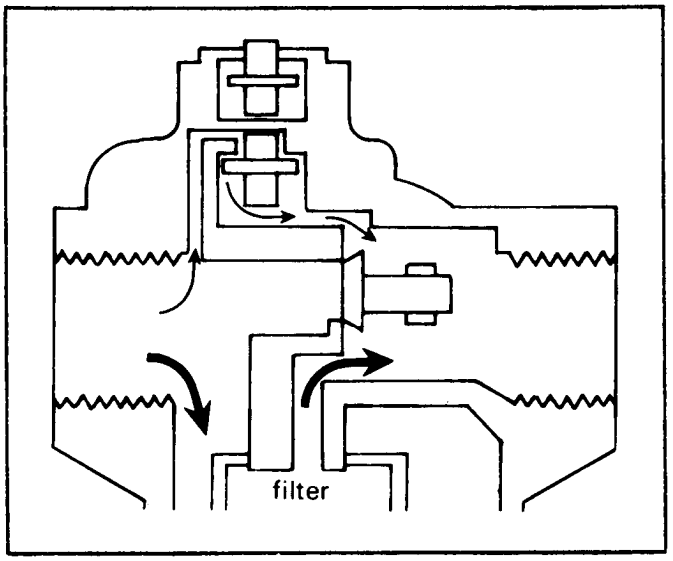

Figure 5-4. Differential pressure indicator.

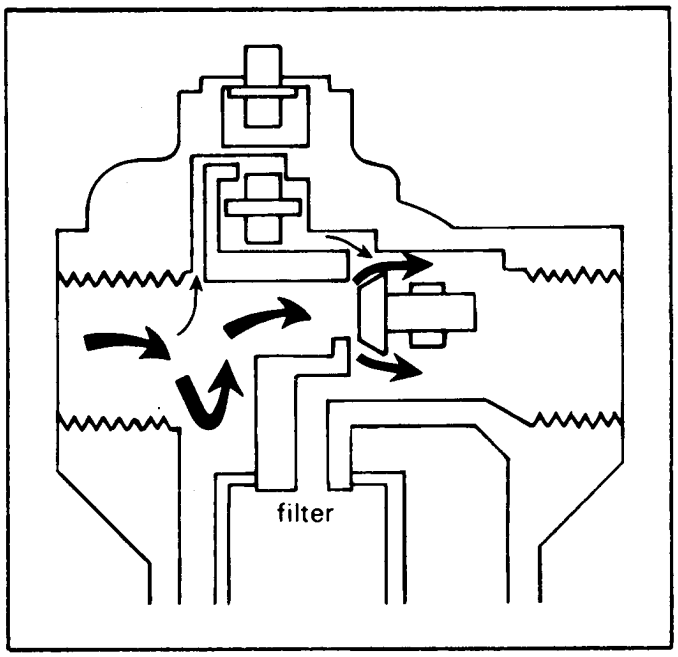

Figure 5-5. Differential pressure indicator "popped out."

Two-Stage Fluid Filters. Two-stage line-type hydraulic system filters are being used in some recent aircraft models. The typical two-stage filter has two filter elements, two bypass valves, and two differential pressure indicators. The first-stage element can filter out smaller particles than the second-stage element can. Normally the fluid passes through both elements, flowing first through the first-stage element and then through the second-stage element. No foreign matter will be left for the second-stage element to remove as long as the first-stage element is unclogged and functioning. If the first-stage element becomes clogged, its bypass valve opens and fluid goes directly from the filter inlet port to the second-stage element, which takes over the job of filtering out foreign particles. Although the second-stage element is not capable of filtering out the very small particles, it can be used until the first-stage element is unclogged.

AIR FILTERS

An air filter is usually located in the line leading into the system supply source. Additional filters may be located at various points in the system lines to remove any foreign matter that may enter the system. Like hydraulic filters, air filters have a removable element and a built-in relief valve. The relief valve opens and bypasses the air supply around the filter element in case the element becomes clogged. Some air filters are equipped with a paper-type element which must be replaced periodically. Others have a mesh-type screen which requires periodic cleaning. The mesh-type screen may be returned to the system after being cleaned and dried.

MAINTENANCE

Filters should be serviced according to the schedules and procedures in technical manuals on the specific aircraft involved. However, the following guidelines apply to the maintenance of all aircraft hydraulic system filters:

- Handle filters carefully. A hole no larger than a pinprick will permit large foreign particles to pass through the element.
- Service filters in a clean area. This will prevent dirt and other foreign particles from entering the system while the filter is being serviced.
- Do not leave a disassembled filter housing unprotected; this may cause contamination.
- Remove wrappings from a replacement element only when the element is to be inspected or installed.
- Hand-tighten the filter bowl to the head. Always safety the bowl and head together.

A popped-out indicator button indicates the need to service the filter. Push the button back in with the system at normal operating pressure. If the button pops out again, the filter needs servicing; if it stays in, the filter is not clogged.

Clean metal filter elements with ultrasonic cleaning equipment only. If ultrasonic equipment is not available, replace the contaminated element with one obtained from supply by repairable exchange. The replaced element is not an expendable item; it must be turned in for cleaning and reissue.